BRITISH MEDICAL ASSOCIATION ★ LIBRARY

PELLAGRA—A CRITICAL STUDY.

BY

JOHN AULDE, M.D.,

PHILADELPHIA, PA.

REPRINTED FROM
THE
MEDICAL RECORD
July 29, 1916.

WILLIAM WOOD & COMPANY
NEW YORK.

BRITISH MEDICAL ASSOCIATION
Library

PELLAGRA—A CRITICAL STUDY.

By JOHN AULDE, M.D.,

PHILADELPHIA, PA.

Introduction.—The object of the present article is to make a critical survey of the dietary defects responsible for the appearance of pellagra, a mysterious malady which now prevails throughout the Southern states. Such a study is made possible through the information contained in two publications[1,2] recently issued by the United States Public Health Service. Like scurvy and beriberi, attacks of pellagra have generally been regarded with suspicion, because of their insidious, seasonal development, with apparent recovery and persistent recurrence. Fortunately, the data at hand is of such a character that we can bring to bear upon this disorder the modern searchlight of scientific inquiry—which gives promise of arousing widespread interest. This favorable outlook is not dependent upon relief from pellagra alone, nor is it limited to scurvy and beriberi, these disorders being rare in this country. On the contrary, the principles underlying the successful treatment of these diseases by diet alone are universally applicable in all diseases, acute, subacute and chronic, functional and organic, infectious and non-infectious, because

Copyright, William Wood & Company.

in every instance we have to contend with the effects, direct and indirect, immediate and remote, arising from dietary deficiency, evidence, complete and in detail, being supplied in the accompanying tabulations.

Historical References.—In view of the very unsatisfactory results attending the investigations of many learned men, physicians, chemists, and bacteriologists, for the past two hundred years, it would not be profitable to review the long campaign. The recent history of attempts to conquer the malady can be briefly stated. By way of explanation, it should be mentioned that there has always been two sides engaged in the controversy—one party claimed that it resulted from some occult dietary fault, corn meal being blamed, while the other party insisted it must be due to an infection.

Several years ago a commission was organized in London, three experts (physicians) were employed, but in their latest published report they say, "their efforts to discover the essential, pellagra-producing food, or the essential, pellagra-preventing food have not been crowned with success." Substantially the same conclusion faces the Public Health Service, in the attempt to demonstrate the infectious organism, this bacteriological work having been under way now for several years in different places throughout the South. In this connection it should be stated that no claim is set up that the pellagrin is free from bacterial infection—far from it; but there is no specific microorganism by which the disorder may be transferred to man or animals, as is the case with diphtheria, tuberculosis, and other infectious diseases.

Two years ago an entirely new theory was launched, which assumes that this disorder must be due to the "over-milling" of corn, by which process of refinement certain vital elements essential to maintain the activity of the various digestive functions are removed, such, for example, as the polishing of rice.

The United States Public Health Service has recently issued an interesting report on vitamines,[3] showing their efficiency in preventing and curing polyneuritis in pigeons fed on polished rice. In this instance, the vitamine was obtained from brewer's yeast, the source of yeast nuclein, first advocated by Vaughan in 1893. While the evidence in favor of yeast vitamine is decidedly favorable, it remains to be seen whether yeast nuclein will produce equally satisfactory results. Thus, "A pigeon kept on polished rice without the yeast filtrate begins to lose weight usually within the first five days, and dies with the typical paralysis of polyneuritis within about twenty days. If 1 c.c. of the yeast filtrate is given to completely paralyzed pigeons, a relief of the paralysis will occur within an hour, and to all outward appearances the pigeon will be restored to a normal condition within twelve hours." The author also refers to the experimental work of Chamberlin and Vedder (1911), who showed "that the neuritis-preventing substance of extracts of rice polishing is removed by filtering through boneblack."

In this connection it should be added that the polyneuritis and paralysis, as occurring in pigeons from polished rice, are a counterpart of the symptoms witnessed in beriberi. In addition, the writer has frequently traced neuritis to excessive rice eating, but has invariably relieved the condition by reorganizing the dietary together with administration of lime salts.

Another important item relates to the laboratory method of concentrating the yeast filtrate for convenience in administration to humans—by using aluminum silicate to secure adsorption. The daily dose of this latter substance for adults amounts to 5 grams (75 grains), and since Dr. Seidell suggests the employment of vitamines for pellagra, we must bear in mind that both silica and aluminum have been held responsible for this disease.

Preceding the "vitamine" theory several specious theories have been advanced within the past few years, one of which deserves attention, viz., that *silica in the food* eaten and water drunk can produce the disease. The plausibility of this conception seemed at first a deduction fully warranted, when it was shown that guinea-pigs, rabbits, dogs, and monkeys fed upon silica developed the characteristic symptoms recognized as belonging to pellagra. The fallacy of this theory was shown by the writer[4] in a short article in which it was indicated how silica became a factor in experimental work. Thus, pellagra is a disorder characterized by a diminished alkalinity of the blood (acid excess), and as a result of this chemical deviation there follows depletion of the lime salts, magnesium salts taking their place. By or through this substitution there is an excess of magnesium salts in the tissues —then the addition of silica, which has an affinity for magnesium, gives rise to a new combination, magnesium silicate. Like sodium silicate, magnesium silicate shows a tendency to harden when it is cooled, and that accounts for the various "rheumatic" affections which involve principally the smaller joints. The sponsor for silica, Alesendrini, an Italian, had previously written a book to prove that pellagra was an infectious disease, but this he renounced when he took up silica, a marked illustration of the uncertainties attending medical investigations.

Along about this period came another specious theory, namely, that pellagra was caused by *the presence of aluminum* in the food—and that the injurious effects arising therefrom might be counteracted by adding fresh animal meat to the dietary, an amusing and ridiculous suggestion to the confirmed vegetarian. The fallacy of this theory will be appreciated by recalling the objections offered to silica as the causative factor—the latter has an affinity for magnesium and aluminum has a double affinity for silica. This accounts for the pellagra symptoms produced by either silica or aluminum in laboratory work, when employed experimentally in animals, usually in massive doses, to study the effects, physical and physiological. Such experiments in this instance have no practical bearing upon the case, since neither silica nor aluminum are taken into the system with our daily food or otherwise in such quantities as would or could produce the characteristic symptoms of the disease.

About a year ago, a thoughtful and industrious Italian, Dr. A. Cencelli, published an incisive paper[5] giving an account of his efforts to counteract the injurious effects of silica in the drinking water. Small pieces of lime were placed in the pipes and reservoirs, and the treatment was applied not only to animals in which the disease had been induced, but also to human beings who had been suffering from pellagra for longer or shorter periods of time, and "the results were in the highest degree satisfactory. Persons who had been ill for a long time immediately improved and were cured in a relatively short space of time, without any change having been made in their mode of life, surroundings or diet."

Evidently, Dr. Cencelli had overlooked my contribution[6] published more than six years ago, from which the following extract will show my trend of thought at that time: "In the opinion of the writer, the underlying, causative factor is to be found in magnesium infiltration, a pathological condition in which there is a depletion of the lime content of the nuclear proteid, being the counterpart of that which occurs in plant life when magnesium salts in excess cause destruction and death of the protoplasm, since magnesium acts as an insulator, impeding the uninterrupted transmission of nerve impulses."

At the time this paper was written serious complaints had been lodged against all corn products employed throughout the South, and it was shown beyond question that the letting of contracts to the lowest bidder had deluged that section of the country with deteriorated grain, the principal sufferers being the inmates of asylums. Indeed, in several instances, charges were brought against the managers for negligence on the part of attendants—it was assumed that the hands and feet of the victims had been scalded, the skin eruptions being so marked as a result of the disease.

In this connection another quotation may be permitted, as follows: "A significant factor in this connection relates to the normal acidity of corn meal; that is to say, when corn meal of good quality is submitted to the usual chemical tests it shows a relative acidity varying from 13 to 25 per cent. When corn meal of an inferior quality—due to decomposition from various causes—is tested, the acidity is found notably increased, in some cases running as high as 95 per cent."

The questions relating to magnesium infiltration and acidity will be better understood from the analysis of the dietary studies, and need not be taken up at this point, but one more reference should not be omitted. Fifty years ago, a Frenchman, Roussel,[7] published a book, from which the following extracts are copied: "Without dietetic measures, *all remedies fail.* . . . When drugs and good food are simultaneously employed it is to the latter that the curative action belongs; the former simply exercises an adjuvant action and is without proved efficacy, except against secondary changes or accidental complications."

The Public Health Service Reports.—These reports are skeletal in character, and yet they furnish a substantial basis upon which to erect the superstructure—they merely supply the daily bill of fare or menu without any details as the nutrient values of the various food materials. Upon the assumed theory that pellagra is due to a dietary deficiency, lack of protein with a superabundance of starchy food-stuffs, the experimental work was taken up with the understanding that it should be continued for a period of two years. The results proved so favorable that a report was made at the end of the first year, and it is this data which we have under consideration. There were really three operations, one embracing two orphanages situated near Jackson, Miss., another located in the grounds of the State penitentiary, with eleven volunteers, while the third was confined to two wards of the Georgia State Sanitarium, an asylum for the insane, where 72 insane women (36 white and 36 colored), all pellagrins, were placed under treatment. As a result of care in the diet there was but one case developed in the orphanages, and all who had the disorder at time of beginning made complete recovery. Altogether, there were more than two hundred cases under observation—and a point worth noting in this connection is that the history of the disease in both institutions showed that it had been confined exclusively to children between the ages of six and twelve years. This peculiarity is readily susceptible of explanation—up to six years of age the children were provided with milk three times a day, but none allowed after that age. This will partly anticipate the value of diet, more fully elaborated in the analysis. The "Pellagra Squad" was confined to criminals who volunteered to take the diet which was supposed to produce the disease, on condition that they receive a pardon from the Governor of the State.

Only two of the operations are included in this paper, the dietary of the orphanages not being available for tabulation—and the accompanying tables are self-explanatory. Thus, to produce the disease a liberal supply of starchy food-stuffs were given, no meats being allowed; to prevent and cure the disease a dietary was provided which included a half pound of beef daily, along with legumes and little of the starchy food. Each dietary study is preceded by the data furnished by the Public Health Service, the computations being worked out by the writer—to show as a whole and in detail the nutrient value of the dietary selected—and special attention should be directed to the importance of the mineral constituents, a computation not usually included in dietary studies.

Dietary Studies.—The object of a dietary study is to determine with mathematical accuracy the nutrient value of the various foods eaten from day to day, or month to month. Sufficient evidence has accumulated to enable us to determine the minimum demands of the system for rebuilding materials and for fuel, or heat-producing materials, so that it is comparatively easy to make computations for different persons employed at different tasks —and allowance must also be made for the season of the year, less fuel material being required in hot weather than during winter. The minimum demand is based upon the needed repairs, sixty grams (about two ounces) of protein being required for this alone. Starting with this, the demand for carbohydrate is estimated at four times the amount, while one-fifth of the whole (about two and one half ounces) should be fat. Food materials taken in excess of the above amount (about twelve and one-half ounces), should be in like proportion to maintain good health. Slight variations may be made from time to time, but when long continued the evidences of debility become well marked and may be readily detected by the skilfull physician.

These nutrient elements, protein, fat and carbohydrates all produce heat, while at the same time serving other purposes; thus, the protein of meat or potato produces the same amount, 4.1 per cent. per gram, but the fat eaten produces more than twice as much, 9.3 per cent. per gram, a gram weighing a little over 15 grains, or one-fourth of a teaspoonful. Meats contain both protein and fat, but no carbohydrate, while legumes (potatoes, etc.), and cereals contain all of the elements—in varying proportions.

The computations to determine the amounts of protein, fat and carbohydrate have been made from Atwater's tables[8] which are generally accepted as authoritative, while the percentages of calcium and magnesium are taken from my book,[9] the data having been compiled from the monograph by Sherman, Mettler, and Sinclair,[10] Department of Chemistry, Columbia University, New York.

The amounts of the various food materials are given in the table, together with the computations, and with the exception of the rates for brown gravy are approximately correct. As there was no heading for brown gravy in Atwater's tables, meat stew was substituted as being nearest in point of protein, fat and carbohydrate and the percentages of calcium and magnesium have been omitted, but this omission will not affect the general results. The probability is that brown gravy would affect the caloric value, since the fat content would be greater, but it would not involve the mineral constituents. In addition it should be mentioned that fried mush is rated as corn bread.

TABLE I—DIETARY STUDY—EXPERIMENTAL PELLAGRA (CAMP STUDY).

Food Materials	Weight, Lbs.	Protein, Lbs.	Fat, Lbs.	Carbohydrate, Lbs.	Calories	Calcium Oxide, Grains	Magnesium Oxide, Grains
Biscuits	41.81	3.637	1.087	23.120	54,357	61.460	55.580
Corn bread	24.56	1.940	1.154	11.371	29,628	15.472	226.870
Grits (hominy)	27.06	.595	.054	4.816	10,076	17.047	250.033
Rice	24.25	.679	.024	5.917	12,370	20.370	101.850
Fried mush	33.87	2.675	1.591	15.681	40,856	21.338	312.958
Brown gravy	37.81	1.739	1.625	2.079	13,959	.....	......
Sweet potatoes	23.62	.708	.496	9.944	21,905	41.335	31.414
Cabbage	4.25	.068	.012	.238	622	17.255	6.247
Collards	23.75	1.068	.142	1.496	5,368	96.425	34.912
Cane syrup	5.94	.142	.....	4.116	7,919	147.609	73.180
Sugar	8.75	.....	.....	8.750	16,275	.....	......
Totals	255.67	13.251	6.185	87.528	213,335	438.311	1093.044
Food eaten per man per day	3.32						
Food utilized per man per day	1.338	.172	.080	1.136	2,770		
		Grams 78	Grams 36	Grams 515	2,766	5.692	14.195

Calories as computed from Atwater's tables, 2,767.

As a result of the *"Camp Dietary"* no less than six of the inmates developed symptoms pertaining to pellagra. At first, there was intestinal irritation (diarrhea), and this was accompanied by lack of appetite, loss of strength and weight. Later, mild nervous symptoms appeared, but it was not until five months after beginning treatment that the "typical" skin eruptions developed.

TABLE II—DIETARY STUDY—GEORGIA STATE SANITARIUM (ASYLUM). SELECTED TO PREVENT AND CURE PELLAGRA.

Food Materials	Quantity	Weight, Oz.	Protein, Lbs.	Fat, Lbs.	Carbohydrate, Lbs.	Calories	Calcium Oxide, Grains	Magnesium, Oxide, Grains
(Breakfast)								
Oatmeal	1 portion	6	.0105	.0018	.0431	107	2.047	6.536
Milk	1 cup	7	.0144	.0174	.0218	140	5.267	.551
Sugar	3 teasp.	1	.....	.....	.0625	116	....	....
Hamburg steak	1 portion	4	.0690	.0680	.....	418	.023	.059
Bread	1 portion	1.5	.0082	.0014	.0481	110	.137	.124
Coffee		...	.....	.....	.....	..	....	....
Totals		19.5	.1021	.0886	.1755	891	7.474	7.270
Food value, each person			Grams 46	Grams 40	Grams 80	888		
(Dinner)								
Beef stew	1 portion	4	.0655	.0872	.....	490	.023	.059
Potatoes	1 portion	4	.0062	.0002	.0522	109	.280	.700
Rice	1 portion	4	.0040	.0002	.0610	121	.210	1.050
Bread	1 portion	1.5	.0082	.0014	.0482	110	.137	.124
Buttermilk	1 cup	7	.0131	.0021	.0210	72	5.267	.551
Totals		20.5	.0970	.0911	.1824	902	5.917	2.484
Food value, each person			Grams 44	Grams 41	Grams 82	901		
(Supper)								
Baked beans	1 portion	2	.0086	.0031	.0245	74	1.881	2.205
Light bread	1 portion	1.5	.0082	.0014	.0482	110	.137	.124
Coffee		...	.....	.....	.....	..	....	....
Sugar	3 teasp.	1	.....	.....	.0625	116	....	....
Buttermilk	1 cup	7	.0031	.0021	.0210	72	5.267	.551
Totals		11.5	.0299	.0066	.1562	372	7.285	2.880
Food value, each person			Grams 13	Grams 3	Grams 70	367		

SUMMARY.

Breakfast		19.5	46	40	80	888	7.474	7.270
Dinner		20.5	44	41	82	902	5.917	2.484
Supper		11.5	13	3	70	372	7.285	2.880
Totals		51.5	103 Grams	84 Grams	232 Grams	2162	20.676	12.634
Food value, each person (lbs. 3.21)		...	103	84	232	2154	20.676	12.634
Food utilized, lbs		Lbs. .929	Lbs. .2290	Lbs. .1863	Lbs. .5139	2154	20.676	12.634

The "*Asylum Dietary*" is thus described in the report: "A cup of sweet milk, about 7 ounces, is furnished each patient for breakfast and one of buttermilk for both dinner and supper. About half a pound of fresh beef and two to two and one-half ounces of dried field peas or dried beans enter into the daily ration. Oatmeal has almost entirely replaced grits as the breakfast cereal; syrup has been entirely excluded. Corn products, though greatly reduced, have not been entirely eliminated."

The menu for Tuesday, selected for this study, is as follows:

Breakfast.—Grits, sweet milk, sugar, broiled steak, hot rolls, biscuits, coffee.

Dinner.—Beef stew, potatoes, rice, bread, buttermilk.

Supper.—Baked beans, light bread, coffee, sugar, buttermilk.

As the exact amounts of oatmeal, sugar, bread, potatoes and rice are not given, it was assumed that they had one portion, the weight of each being added in the proper column. Thus, the total amount of food eaten for the day is 51.5 oz., or 3.21 lb., two-fifths of which is milk and buttermilk.

Table No. III, "Comparison of Dietary Values," has been added for the purpose of showing the "one-sided" character of the dietary selected instead of a "balanced ration"—it shows at a glance just how the two dietaries could be readjusted to meet the normal demands of the system.

TABLE III—COMPARISON OF DIETARY VALUES.

	ACTUAL RATION				"BALANCED RATION"			
	Protein, Grams	Fat, Grams	Carbohydrate, Grams	Calories	Protein, Grams	Fat, Grams	Carbohydrate, Grams	Calories
Camp dietary..........	78	36	515	2766	78	97	312	2501
Asylum dietary........	103	84	232	2154	103	128	412	3301

Analysis of the Tabulations.—By comparison and contrast we may arrive at definite conclusions, at least from a mathematical viewpoint, but there are physiological and chemical questions to be brought into consideration. For example, it is easy to make the calculation and find that each dietary carries about two pounds a day more than is utilized; that the protein content of the "Camp Dietary" is 30 per cent. above the minimum, while the protein content of the "Asylum Dietary" is 70 per cent. above the minimum; that both dietaries were lacking in the fat content of a "balanced ration"; that the "Camp Dietary" had a surplus of carbohydrate of about 200 grams while the "Asylum Dietary" had a deficiency of like amount. Most important, however, is the notable discrepancy in the mineral content—the "Camp Dietary" contains about two and one-half times as much magnesium as lime, while the lime content of the "Asylum Dietary" is one and one-half times the magnesium content. Now comes the question as to which has the greater influence, the discrepancy in the fat and carbohydrate, or the reversal in the proportions of the calcium and magnesium? Vegetarians live a normal life without fat, animal fat, so that question is settled. Hard working men will consume food which produces twice as many heat units (calories), as these men in the camp, who worked four and a half days per week, enjoy life and apparently suffer no bad effects from the increased intake of carbohydrates. Again, the absence of carbohydrate from the dietary is not at all serious, as shown by the freedom of the asylum inmates from recurrences of the disease, several of whom had experienced two or more attacks. Further, there were more than 72 patients under treatment at the beginning of the course, but some of them so far recovered under the treatment that they were permitted to go to their homes. It is doubtful if the excess of protein in the "Asylum Dietary" could have exercised such a marked change, since the "Camp Dietary" contained 30 per cent. above the minimum requirement.

This leaves for consideration the function of mineral constituents, but that harks back to the protein element in the dietary. It is not an accumulation of fat which gives a man mental ability and physical strength; nor can either be claimed for carbohydrate. Hence, the necessity for interrogating nature.

In the "Asylum Dietary" nearly 16 of the 20 grains of lime were derived from the milk and buttermilk, while the magnesium came chiefly from oatmeal, rice and baked beans—in fact, when a child gets 7 ounces of sweet milk and 6 ounces of oatmeal, the mineral balance is in favor of lime by more than one grain. But a child twelve months of age will take a quart of milk a day and thrive on it—by which he gets about 24 grains of lime daily.

Now, let us examine the "Camp Dietary"—the lime was derived principally from biscuits, sweet potatoes, collards and cane syrup, while the magnesium content came from corn products almost exclusively —with the rice content, it make up nine-tenths of the whole. Had it not been for the cane syrup the "pellagra symptoms" would have appeared much earlier and shown greater severity. Then, if we add to this a decomposed or deteriorated corn preparation with an excessive relative acidity, we have a fairly complete picture of the conditions which precipitated this malady in the first place and kept it alive for two centuries.

In the usual dietary of the ordinary home in this country, Langworthy has calculated that the average intake of calcium ranges from 10.5 to 15 grains daily, the magnesium content being estimated at half this amount—and this apparently accounts for the prevention of the recurrence of the disease in the two wards of the Georgia State Sanitarium.

Deductions from the Evidence.—The general reader must concede that we have a pretty good case, but the evidence is not all in. For example, as soon as the camp subjects began to suffer from intestinal irritation, an examination of the blood would have shown that they were suffering from calcium depletion incident to the acid excess; that the normal alkalinity of the blood was diminished, interfering with its oxygen-carrying capacity; that the heart action was enfeebled as a result of the chemical deviation; and finally, that nerve conduction was impaired—in consequence of the calcium depletion and in the coincident substitution of magnesium. It is precisely on the same principle that a farmer would not permit the use of lime on his land where it contained a large percentage of magnesium, because he knows that such a combination would be fatal to his crops.

The essential factor in the production of pellagra, scurvy and beriberi, and in fact, all chronic diseases, is the mineral deficiency in the protein molecule. The protoplasmic cell is the unity of which the body is made up, just as the bricks are the unit in a solid brick wall, except that these cells are living organisms, possessing all the characteristics and properties of life, nutrition (absorption), excretion, motility, reproduction and response to stimuli, and to this should be added the psychic. These cells are made up of the food taken into the system; they are composed of molecules—of fat, carbohydrate and protein molecules, and the functional activity and physical energies of the protoplasm are dependent upon the proper distribution of the mineral salts, not in the fat and carbohydrate molecules, but in the protein molecules. It is the protein molecule which enables the protoplasm to perform its special or specific functions in muscular tissue, kidney structure, in the liver, the lungs, the brain, the reproductive organs, and finally, maintains correlation with all the organs through the medium of the nervous system. When illness supervenes, there is at once an acidity, or diminished alkalinity of the blood, and lime being a stronger base than the others, this substance combines with the acid and is eliminated. Thus, a person living on crackers and water for three days will lose more lime than the intake—and he will begin to lose it during the first day of the experiment, all of which goes to confirm my contention that calcium depletion is responsible for pellagra.

Bacterial Infection.—This claim is further confirmed by a study of bacterial infection. Under normal conditions it is the protein molecule which enables us to ward off disease, by maintaining an antiseptic condition of the blood; by promoting or favoring the production of bacteriolysins, substances which dissolve the bacteria; by the production of poisons (bactericides), which kill the invading hosts of bacteria; by augmenting and strengthening the functional activity and physical energies of the phagocytes, which surround and digest the bacteria when found in the blood stream and in the tissues, this peculiar feature of defense being regulated by chemotaxis. In none of the conditions can we depend upon nature when the blood and lymph and tissues are surcharged with magnesium salts, because bacteriologists have shown time and again that when the blood is charged, surcharged, with a considerable percentage of magnesium sulphate (Epsom salts), it loses its bactericidal properties.

On the other hand, the presence of magnesium salts in excess seems to favor the growth and multiplication of bacteria, the constitution of which is substantially the same as the protoplasm, simply because magnesium salts in excess are debilitating —as in the case when they are substituted for the calcium salts in the body tissues, their function is impaired. Normal nucleoproteins are converted into magnesium nucleoproteins and these latter lack the property of imbibition (absorption), and this explains why the wise farmer refuses to put lime salts surcharged with magnesium on the soil; he knows that the tiny rootlets will shrivel up, turn black and die and that his crop will be a failure—and such is substantially the picture we see when the searchlight of scientific inquiry is thrown on the disease known as pellagra.

REFERENCES.

1. Experimental Pellagra in the Human Subject Brought About by a Restricted Diet. Bulletin of the U. S. Public Health Service.
2. The Prevention of Pellagra, a Test of Diet Among Institutional Inmates. Bulletin of the U. S. Public Health Service.
3. Vitamines and Nutritional Diseases, by Atherton Seidell, Bulletin of the U. S. Public Health Service, 1916.
4. Aulde: Treatment of Pellagra, *Lancet-Clinic*, June 12, 1915.
5. Cencelli: New Theories and Investigations Concerning Pellagra, *Lancet*, April 17, 1915.
6. Aulde: Pellagra—An Inquiry, *New York Medical Journal*, Dec. 4, 1909.
7. Roussel, Theophile: "Traite de la Pellagra et des Pseudo-Pellagres," Paris, 1866.
8. Atwater: The Chemical Composition of American Food Materials, Washington, D. C., 1906.
9. Aulde: The Chemic Problem in Nutrition (Magnesium Infiltration), Philadelphia, 1912.
10. Sherman, Mettler and Sinclair: Calcium, Magnesium, and Phosphorus in Food and Nutrition, Washington, D. C., 1910.

1305 Arch Street.